Canadian Decision Support System for Managing a Nuclear Emergency
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For radiological and nuclear emergencies, the Federal Nuclear Emergency Plan (FNEP) supplements Canada’s all-hazard Federal Emergency Response Plan (FERP) by providing extra governance and scientific/technical arrangements to address radiological public health consequences. The FNEP describes the framework used to coordinate the scientific aspects of the federal government’s response to a nuclear emergency affecting Canadians at home or abroad. It is a multi-departmental plan, bringing together the scientific and technical resources of 18 federal organizations into a single specialized emergency response team to support decision making at all levels of government.

Nuclear emergency response requires the integration and assessment of a large set of scientific data from distributed sources to inform actions to reduce the effects of ionizing radiation on people and the environment. To fulfill this mandate, a Decision Support System (DSS) has been developed to allow scientists analyze an incident and communicate recommendations to decision-makers. This DSS hinges on nuclear emergency functions assigned to federal departments and agencies. These functions can be grouped into the following five categories: (1) Source term characterization: determines how much radioactive material could have been released and how this might change over time; (2) Hazard prediction through modelling: determines where a radioactive release might go and what the potential pathways and exposures would be; (3) Hazard assessment through measurements: determines where the radiation actually went and what the potential pathways and exposures are; (4) Hazard impact assessment: determines the impact on people and the environment and recommended protective actions; and (5) Information sharing to share data, situational awareness and recommendations with emergency management centres and decision-makers. These functions are fulfilled using various tools described below.

1. Source term characterization

VETRA – CANUDD specific source term estimate tool

Inputs:
- Core damage state
- Spray and filter system use
- Hold up time in containment
- Duration of release

Output:
- Activity level of 48 Radio-nuclides including Tritium

1. Source term characterisation

2. Radiological hazard prediction through modelling

ARGOS – Accident Reporting Guidance and Operational System

Expert System for:
- Interfacing with the Canadian Meteorological Centre (CMC) for radiological atmospheric dispersion modeling
- Air-chemistry observations
- Radionuclides concentration in the air
- Radionuclides deposition on the ground
- Ozone, ground-level, sunshine & operation dose

3. Radiological hazard assessment through measurements

Fixed Point Surveillance System

There are 77 fixed point surveillance stations distributed across the country, including around nuclear power generating stations and near mobile nuclear powered vessels. The stations are operated on a 24/7 basis and data can be downloaded to a centralized database in near real-time.

Specialized software is used to analyze and identify the source and the composition of potential releases of radioactive material

Aerial Survey

Aerial radiation surveys deliver a rapid way to characterize the extent, severity, and isotopic content of deposition

Initial post-incident surveys following a serpentine path give a general outline of the contaminated area

Follow-up surveys are conducted to provide a detailed map and indicator hotspots, and repeating surveys indicate time evolution of contamination

Ground survey

Gamma vehicle borne survey with real-time data synchronization into a web mapping application

Light portable x-ray point detectors with batteries that can be quickly deployed to report information from distance to mobile networks during closed up

In situ measurements with high purity germanium detectors for characterization of contaminated areas

Rapid Response Kit of detection equipment ready to be deployed across the country

Sampling and sample analysis

- Capability to collect and analyze samples of air, soil, water, vegetation and waste
- Identification and quantification of radionuclides in the samples
- Mobile Nuclear Laboratories (high purity germanium-detectors)
- Samples are then sent to head quarter laboratory for automated, high throughput analysis

Contamination control

Guidance deployment of tents, portable monitors and pancake detectors to monitor field team offices and set up a decontamination line

Equipment, vehicles and samples are monitored when the scientific teams are coming back from contaminated zones

4. Radiological hazard impact assessment

Data Integration and Analysis

Environmental Metrology Systems

Extensive data can be downloaded to a centralized database in near real-time

Airborne survey

- Collection of data through satellite communication
- Be quickly deployed to report information from distance
- Give a general overview of the area

Spatial Analysis

- E-Map
- Geospatial and Temporal Awareness
- Document Sharing & Event Logging
- SharePoint
- Collaboration & Spatial Analysis
- Environmental Data
- Information Sharing
- Radiation Data

3. Radiological hazard assessment through measurements

Gaps and Future Development

While the Canadian Decision Support System (DSS) for managing a nuclear emergency is mature, there are still some areas that need further development. It is important to:

- Automate integration of field data into the analysis and long term dose projections
- Managing continuous release events
- Source term reconstruction: further development of rapid and automated tools to improve the data integration process and reconstruction speed
- Use of a probabilistic approach to estimate uncertainties in dose projection assessments

Conclusion

The Canadian Decision Support System for managing a nuclear emergency is a mature system that was developed in collaboration between many federal departments. It has been tested through regular exercises and drills. In particular, it was successfully used during the Fukushima Daiichi Nuclear Accident of March 2011 and in a recent full scale exercise in Canada which consisted of responding to a major (beyond design basis) at the Darlington Nuclear Generating Station. In both cases, outputs from the system were used by emergency response organizations to inform their decision-making process.